

WHAT IS CLAIMED IS:

1. A method for generating and detecting ultrasonic surface displacements on a remote target comprising the steps of:

5 using a first pulsed laser beam to generate ultrasonic surface displacements on a surface of the remote target;

10 using a second pulsed laser beam coaxial with said first pulsed laser beam to detect the ultrasonic surface displacements on the surface of the remote target;

collecting phase modulated light from the second pulse laser beam either reflected or scattered by the remote target; and

15 processing the phase modulated light to obtain data representative of the ultrasonic surface displacements on the surface of the remote target.

2. The method of Claim 1 wherein the step of processing the phase modulated light further comprising the steps of:

20 using an interferometer to demodulate the phase modulated light for creating at least one optical signal;

25 converting the at least one optical signal into at least one digital signal; and

using a digital signal processor to process the at least one digital signal.

3. The method of Claim 2 wherein the step of converting the at least one optical signal into at least one digital signal further comprising the steps of:

5 converting the at least one optical signal into at least one analog signal; and
 converting the at least one analog signal into at least one digital signal.

10 4. A apparatus for generating and detecting ultrasonic surface displacements on a remote target comprising:

 a first pulsed laser to generate a first pulsed laser beam to produce ultrasonic surface
15 displacements on a surface of the remote target;
 a second pulsed laser to generate a second pulsed laser beam coaxial with said first pulsed laser beam to detect the ultrasonic surface displacements on the surface of the remote target;
20 collection optics for collecting phase modulated light from the second pulsed laser beam either reflected or scattered by the remote target;
 an interferometer to process the phase modulated light and generate at least one output
25 signal; and
 a processor to process the at least one output signal to obtain data representative of the ultrasonic surface displacements on the surface of the remote target.

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5 5. The apparatus of Claim 4 further comprising
an intensity controller to adjust on a pulse-by-pulse
basis the intensity of the second pulsed laser beam in
proportion to the intensity of the phase modulated
light collected by the collection optics.

10 6. The apparatus of Claim 4 wherein the first
pulsed laser emits a laser beam of coherent light of
about 10 microns in wave length.

15 7. The apparatus of Claim 4 wherein the
interferometer is self-stabilized using substantially
100% of the phase modulated light delivered to the
interferometer by the collection optics.

8. The apparatus of Claim 4 further comprising
an optical ranging unit to calculate a distance by
which the remote target is separated from the
apparatus.

9. A large area composite inspection apparatus for measuring ultrasonic surface displacements on a surface of a remote target comprising:

- 5 a detection laser to generate a pulsed laser beam to detect the ultrasonic surface displacements on the surface of the remote target;
- collection optics for collecting phase modulated light from the pulsed laser beam either reflected or scattered by the remote target;
- 10 an interferometer to process the phase modulated light collected by the collection optics; said interferometer comprising: a first cavity having a first confocal lens structure; a second cavity having a second confocal lens structure; a
- 15 device for dividing incoming de-polarized light into a first polarized light component and a second polarized light component wherein said device also directs said first and second polarized light components into the first and second cavities;
- 20 a control system to adjust said first and second cavities such that a ratio of light transmitted through each cavity to light reflected back through each cavity remains substantially constant; and
- 25 a processor to process the light transmitted through the first cavity, the light reflected back through the first cavity, the light transmitted through the second cavity, and the light reflected back through the second cavity, all in order to obtain data
- 30 representative of the ultrasonic surface displacements on the surface of the remote target.

10. The large area composite inspection apparatus of claim 9 further comprising an intensity controller which adjusts on a pulse-by-pulse basis the intensity of the pulsed laser beam in proportion to the intensity of the phase modulated light collected by the collection optics.

11. The large area composite inspection apparatus of claim 9 further comprising a positioning apparatus to move the detection laser across the surface of the remote target and then record and index the data detected by the large area composite inspection apparatus.

12. The large area composite inspection apparatus of claim 9 wherein the positioning apparatus is a gantry positioning apparatus.

13. The large area composite inspection apparatus of claim 9 further comprising a generation laser to generate a pulsed laser beam to detect generate the ultrasonic surface displacements on the surface of the remote target.

14. The large area composite inspection apparatus of claim 9 wherein the generation laser and the detection laser coaxially apply laser beams to the surface of the remote target.

15. A method for generating and detecting ultrasonic surface displacements in a remote target comprising the steps of:

- generating ultrasonic surface displacements
- 5 in the remote target;
- directing a pulsed laser beam to detect the ultrasonic surface displacements on the surface of the remote target;
- collecting light from the pulsed laser beam
- 10 either reflected or scattered by the remote target;
- processing the light collected from the remote target using an interferometer;
- said interferometer comprising: a first cavity having a first confocal lens structure; a second
- 15 cavity having a second confocal lens structure; a device for dividing incoming de-polarized light into a first polarized light component and a second polarized light component wherein said device also directs said first and second polarized light components into the
- 20 first and second cavities; a control system to adjust said first and second cavities such that a ratio of light transmitted through each cavity to light reflected back through each cavity remains
- substantially constant; and a plurality of detectors to
- 25 detect the light transmitted through the first cavity, the light reflected back through the first cavity, the light transmitted through the second cavity, and the light reflected back through the second cavity, all in order to obtain data representative of the ultrasonic
- 30 surface displacements on the surface of the remote target.

16. The method of claim 15 further comprising the
step of adjusting on a pulse-by-pulse basis the
intensity of the pulsed laser beam in proportion to the
intensity of the light collected from the remote
5 target.

17. The method of claim 15 further comprising the
step of indexing the detection laser across a surface
of the remote target and then recording the data on a
10 point-by-point basis.

18. The method of claim 15 wherein the step of
generating ultrasonic surface displacements in the
remote target is accomplished a generation laser beam.
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19. The method of claim 15 wherein the pulsed
laser beam and a beam of the generation laser are
coaxially applied to the surface of the remote target.

20. An optical interferometric apparatus for measuring incoming de-polarized light comprising:

a first cavity having a first confocal lens structure;

5 a second cavity having a second confocal lens structure;

a beam splitter for dividing incoming de-polarized light into a first polarized light component and a second polarized light component and for
10 directing said first and second polarized light components into the first and second cavities;

a first collection optics for collecting light transmitted through the first confocal lens structure wherein said collected light being
15 represented by variable V_{T1} ;

a second collection optics for collecting light reflected back through the first confocal lens structure wherein said collected light being represented by variable V_{R1} ;

20 a third collection optics for collecting light transmitted through the second confocal lens structure wherein said collected light being represented by variable V_{T2} ;

a fourth collection optics for collecting
25 light reflected back through the first confocal lens structure wherein said collected light being represented by variable V_{T2} ;

a control system for adjusting the first cavity to vary an amount of light transmitted through
30 the first cavity in relationship to an amount of light reflected back through the first cavity; and

a second control system for adjusting the

second cavity to vary an amount of light transmitted through the second cavity in relationship to an amount of light reflected back through the second cavity.

5 21. The optical interferometer of claim 20 further comprising:

 a first detector to quantify V_{T1} ;
 a second detector to quantify V_{R1} ;
 a third detector to quantify V_{T2} ; and
10 a fourth detector to quantify V_{R2}

 22. The apparatus of claim 20, wherein the first and second cavities are adjusted to maintain the following relationship:

15
$$\frac{V_{R1}}{V_{R1} + V_{T1}} = \frac{V_{R2}}{V_{R2} + V_{T2}} = \text{a constant}$$

wherein the constant is a real number between 0.5 and 1.0.

23. An interferometric apparatus for measuring light, comprising:

a first cavity having a first confocal lens structure;

5 a second cavity having a second confocal lens structure;

a polarized beam splitting assembly to divide incoming de-polarized light into a first polarized light component and a second polarized light component
10 wherein said polarized beam splitting assembly directing said first and second polarized light components into the first and second cavities;

a first detector positioned to detect a first amount of light transmitted through the first confocal lens structure wherein said first amount being
15 represented by variable V_{T1} ;

a second detector positioned to detect a second amount of light transmitted through the second confocal lens structure wherein said second amount
20 being represented by variable V_{T2} ;

a third detector positioned to detect a first amount of light reflected back through the first confocal lens structure wherein said first amount being represented by variable V_{R1} ;

25 a fourth detector positioned to detect a second amount of light reflected back through the second confocal lens structure wherein said second amount being represented by variable V_{R2} ;

a first control system to adjust and tune the
30 first cavity to adjust V_{R1} relative to V_{T1} ;

a second control system to adjust and tune the second cavity to adjust V_{R2} relative to V_{T2} ;

24. The apparatus of claim 23 wherein the first and second cavities are adjusted to maintain the following relationship:

$$\frac{V_{R1}}{V_{R1} + V_{T1}} = \frac{V_{R2}}{V_{R2} + V_{T2}} = \text{a constant}$$

wherein the constant is a real number between 0.5 and 1.0.

25. The apparatus of claim 23 wherein the constant is 0.75.

26. The apparatus of claim 23 wherein said first and second confocal lens structures each comprise:

a first partially reflective spherical mirror;

a second partially reflective spherical mirror;

each of said partially reflective spherical mirrors having a curvature of radius R1;

said first and second partially reflective spherical mirrors facing each other and being spaced from each other by a distance approximately equal to R1.

27. The apparatus of claim 23 wherein each of the first partially reflective spherical mirrors is slidably mounted upon piezoelectric mounts to permit the distance between the first partially reflective spherical mirror and the second partially reflective spherical mirror to be adjusted.

28. The apparatus of claim 23 wherein each of the first and second confocal lens structures has at least one of the partially reflective spherical mirrors
5 slidably mounted to permit adjustment in the distance between the first partially reflective spherical mirror and the second partially reflective spherical mirror.

29. The apparatus of claim 23 wherein said at
10 least one of the partially reflective spherical mirrors is slidably adjusted using a piezoelectric device.

30. The apparatus of claim 23 further comprising:
15 a first quarter wavelength plate relative to the wavelength of the incoming depolarized light wherein said first quarter wavelength plate being placed between the first polarized beam splitter and the first cavity; and a second quarter wavelength plate relative to the wavelength of the incoming de-polarized light
20 wherein said second quarter wavelength plate being placed between the second polarized beam splitter and the second cavity.

31. The apparatus of claim 23 wherein the
25 polarized beam splitting assembly comprises a first polarized beam splitter to separate out the first polarized light component and to direct said first polarized light component into the first cavity wherein said first polarized beam splitter also transmitting
30 the second polarized light component to a second polarized beam splitter that directs said second polarized light component into the second cavity.

32. An interferometric apparatus for measuring light, comprising:

a first cavity having a first confocal lens structure;

5 a second cavity having a second confocal lens structure providing a means for dividing incoming depolarized light into a first polarized light component and a second polarized light component and for directing said first and second polarized light
10 components into the first and second cavities providing a plurality of detectors for measuring the amount of light transmitted through the first confocal lens structure relative to the amount of light reflected back through the first confocal lens structure
15 providing a relationship which is expressed by formula $(V_{R1} / (V_{R1} + V_{T1}))$;

a detector for measuring the amount of light transmitted through the second confocal lens structure relative to the amount of light reflected back through
20 the second confocal lens structure providing a relationship which is expressed by formula $(V_{R2} / (V_{R2} + V_{T2}))$; and

a control system for adjusting the first and second cavities to maintain the following relationship
25 despite a variation in intensity of the incoming depolarized light:

$$\frac{V_{R1}}{V_{R1} + V_{T1}} = \frac{V_{R2}}{V_{R2} + V_{T2}} = \text{a constant}$$

30 wherein the constant is a real number between 0.5 and 1.0.

33. An interferometric apparatus comprising:
- a first cavity having a first confocal lens structure;
 - a second cavity having a second confocal lens structure;
 - a device for dividing incoming de-polarized light into a first polarized light component and a second polarized light component, said device also directing said first and second polarized light components into the first and second cavities;
 - a control system to adjust said first and second cavities such that a ratio of light transmitted through each cavity to light reflected back through each cavity remains substantially constant.